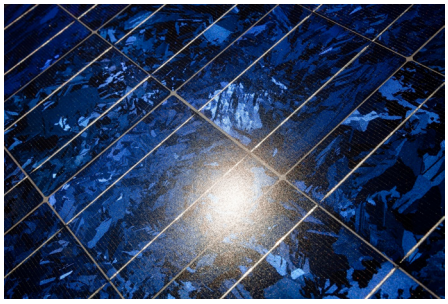
Solar PV: Will it work at this light level?

EVEN TODAY, WHEN SOLAR PANELS ARE BEING INSTALLED IN EVERY REGION OF THE WORLD AND ELECTRIFYING MANY HOMES, SOME PEOPLE REMAIN APPREHENSIVE ABOUT SOLAR PHOTOVOLTAIC'S CAPABILITIES.

"Will it work at this light level?"

This is one of the many questions that people ask solar experts these days. So to finally put an end to the myths and speculations, allow us then to answer it with a simple — YES!

As long as there is visible light, even how little it could be — solar panels can produce power.



But to understand this concept better, it is important to know first the basic principles behind the working of solar PV cells.

Similar to what happens in our daily lives, unless we are forced to perform a task, we seldom get out of our homes to be 'active.' So people would require some sort of motivation or 'activation energy' to get us moving .

In the case of PV cells, which are made of semiconductor, light is the "activation energy." This light "knocks-off" electrons circulating around the atoms inside the photovoltaic cells, and if any conducting metal (like a thin wire) is attached to the positive and negative sides to form an electrical circuit, electric current will flow: this is how power is generated.

In the following sections, we'll explain the "why" and "how" in more detail.

LIGHT AS "ACTIVATION ENERGY"

Solar PV cells do not respond to all forms of light. Only light energy of specific wavelengths (or colors) can excite the electrons.

Specifically, visible and near-visible spectrum range of the light energy from sun possesses the adequate energy level required by a common solar PV cell to be active. Before going further, it is better to understand the relation between energy, wavelength and frequency, with the help of a very famous formula from physics, as seen on the orange box on the right.

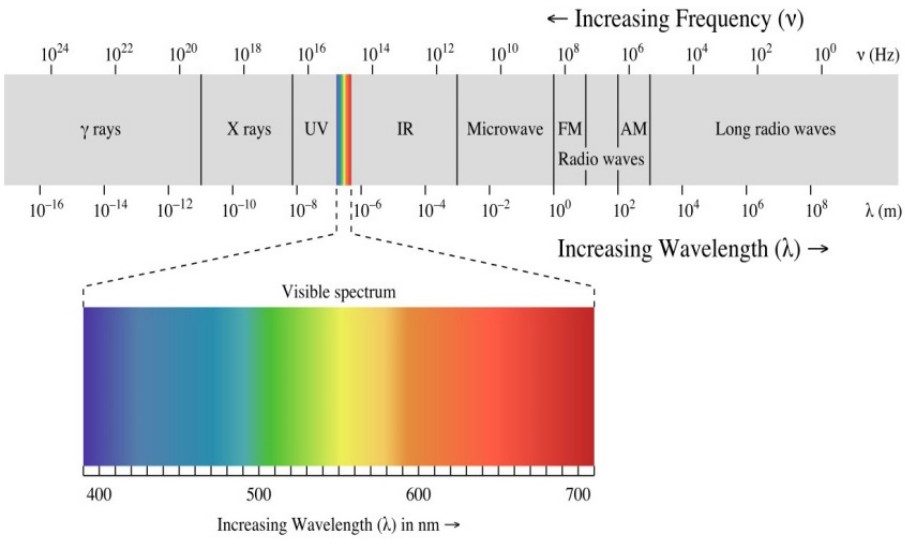
It can be observed that if the wavelength is short (or less) then the equivalent energy would be high or vice-versa. The light energy from sun comes in the form of photons. In physics, the photon energy (sun's light energy) is dependent on the wavelength of light.

The wavelength of visible light has a range of 400nm to 700nm wavelength, as depicted in FIG-1.

$E=hv=h(C/\lambda)E=hv=h(C/\lambda)$

(where h is the Plank's constant, C is the speed of light, λ is the wavelength and ν is the frequency)

FIG-1: SPECTRUM OF LIGHT



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With the help of the given formula and figure, the range of wavelengths can be converted into equivalent photon energy. After calculating, for the red side of the visible light spectrum, λ≈ 700nm, therefore the energy comes out to be E=1.77eV and for the violet side of the visible spectrum, λ≈ 400nm, the energy output is E=3.10eV. (Here, eV (also written electronvolt) is a unit of energy which is equivalent to approximately 1.602×10−19 joule).

Now, coming back to our discussion on activation of solar cell , a typical silicon-based Solar PV cell requires a minimum of 1.1eV of energy to generate the electron flow. Having understood the energy calculation from a given wavelength, we can observe that the visible range of light contains the energy range from 1.77eV (700nm) to 3.10eV(400nm) , which is sufficient to break the electrons from the atom to conduct electricity.

Even the wavelengths having value between 700nm to 1127nm (in infra-red range) possess energy range of 1.77eV to 1.1eV, which is adequate for knocking-off the electron. At energies lower than 1.1 eV, photons do not have enough energy to dislodge the electrons.

WHAT DOES THIS MEAN TO US IN OUR DAY-TO-DAY LIFE?

This means then that as long as there is light, the photons with energy higher than 1.1eV will activate the cells, no matter what the time of the day it is or how intense the light may be.

Indeed, even those handheld calculators and toys equipped with small solar cells can operate under low levels of domestic lighting. But generation of adequate power output from a solar PV system for a larger load requires higher daylight intensity.

CONCLUSION

As long as there is a sufficient amount – and quality – of light (or sun's energy), solar PV cells will produce at least some power. However, just because a PV system can produce power, *does not mean that it can produce enough power* for the particular application -- or that it is economic to do so.

Assessing these questions requires greater understanding of how the available light levels relate to the desired applications -- and how many PV cells must be installed, and what the project economics are, as a result.

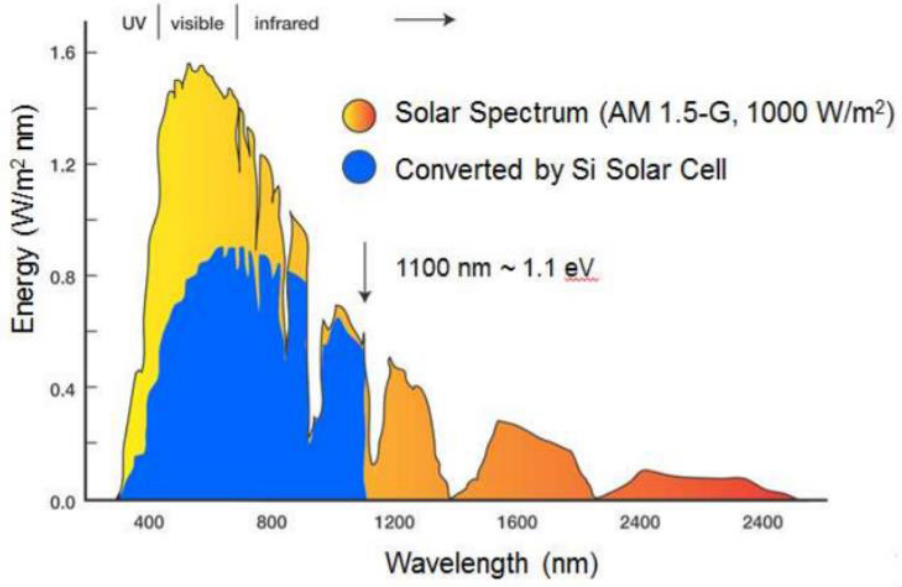

FIGURE 2:
FIGURE 2 EXPLAINS THAT ONLY THE PHOTONS IN THE BLUE COLORED REGION OF THE GRAPH CAN BE ABSORBED AND USED FOR CREATION OF ELECTRICITY IN SILICON SOLAR CELLS. IF WE MOVE WITH LONGER WAVELENGTH ON X-AXIS, THEN NO PHOTONS ARE CAPABLE.